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17. ABSTRACT (MAX. 250 WORDS) A main problem arising in the study of categorizing behavior in preschool children by means of sorting procedures was that performance appeared to be very much a function of the child's comprehension of the particular verbal instructions employed by the experimenter in presenting the task. The specific aims of the first study were to investigate the nature and frequency of occurrence of cognitively structured object manipulations in infants and to assess the role of several different stimulus contrasts in the instigation of such behavior. No specific sorting instructions were given, but infants were simply encouraged to "play with" or "fix" the test objects.

The purposes of the follow-up study were to examine changes in the nature and frequency of occurrence of the serial ordering and object grouping behaviors, to examine changes in some of the qualitative features characterizing the children's object arrangements, and to see whether individual differences showed any stability over the developmental interval between the first and second testing.

The testing procedure for each task involved placing the array of test objects in front of the child, who was then encouraged to play with them with such comments as "See these? - you play with them - you fix them all up." Since the procedure was intended to elicit spontaneous behavior, the examiner intruded as little as possible, except to encourage the child to continue to play with the objects if he had become disinterested. Results showed that, at twenty months, the most common ordering behavior consisted of successive manipulation of four objects of one kind. When the infants were retested at forty months, successive manipulation of all eight objects in both groups occurred more than three times as frequently as at twenty months, even with the general instructions simply to "play with" or "fix" the objects.

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Developmental changes in categorizing behavior from infancy to the early pre-school years[1, 2]

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The study of categorizing behavior in children and adults has been an active area of psychological research for many years, and it continues to remain so during the currently resurgent interest in cognitive development. One type of categorizing behavior which has been rather widely investigated is that involved in performance on free sorting tasks, or in certain matching with standard problems, in which the subject is asked which of an array of stimulus objects are most alike, or belong together, or perhaps he is asked to sort the stimuli into a number of groups. In such tasks, the subject must identify for himself the stimulus attributes which provide a basis for grouping, and if several alternative sets of attributes or dimensions are available, he must decide which of these provides the most salient criteria for categorization. Sorting procedures of this type have been employed to determine whether subjects at various ages are capable of categorizing stimulus material of various levels of complexity (2, 10), whether particular stimulus characteristics are generally prepotent as criteria for categorization (4, 7), and in more recent years, to identify groups of individuals whose categorizing be-

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havior appears to be preferentially determined by a special sensitivity to particular types of stimulus attributes, or in short, by a particular "cognitive style" (5).

The majority of previous studies of sorting behavior in children have dealt primarily with school aged subjects, with a few exceptions in which children as young as three or four years were studied (1, 6, 11). Most recently, Inhelder and Piaget (3) have published a report of their extensive studies of the development of seriation and classification behavior in children from 2 to 13 years of age.

One of the main problems arising in the study of categorizing behavior in pre-school children by means of sorting procedures, is that performance appears to be very much a function of the child's comprehension of the particular verbal instructions employed by the experimenter in presenting the task. In the course of an attempt to develop effective sorting instructions for three year olds in an earlier study (9), the speaker made some observations suggesting that with very young children and with infants as well, if one presented sets of simple contrasting test objects without specific sorting instructions, it was possible to observe a variety of cognitively organized manipulations of these objects. These observations led to a systematic study of such behavior in 12 to 24 month old infants, which was completed about a year and one-half ago (8). The research to be reported here today consists essentially of a longitudinal follow up of 22 infants included in this first study, who were re-examined with essentially the same procedures at approximately 40 months of age.

The specific aims of the first study were to investigate the nature and frequency of occurrence of cognitively structured object manipulations in infants, and to assess the role of several different stimulus contrasts

in the instigation of such behaviors. Forty-eight infants were tested with four simple object grouping tasks. No specific sorting instructions were given, but infants were simply encouraged to "play with" or "fix" the test objects. The results indicated that a considerable degree of primitive grouping or categorizing behavior was observable in the infants' object manipulations. Such behavior took two major forms: successive, or serial manipulation of similar objects, and, somewhat less frequently, spatial grouping of similar objects.

Although occurring with only moderate frequency, the appearance of these behaviors in infants was regarded as quite significant, since these subjects were essentially pre-verbal children who were not responding to instructions to sort or classify on the basis of similarities. Rather, their cognitively guided manipulations appeared to be more or less spontaneously instigated, by merely being confronted with certain arrays of test objects in a free response situation. The nature and early appearance of these responses reinforced our earlier conviction that they represent, in some sense, rudimentary, pre-verbal precursors of the more highly developed processes involved in the categorization behavior of older children.

Upon completion of this first study, the desirability of re-examining the infants at a point when language development was well underway seemed quite clear. We decided, therefore, to re-administer the original tasks when the infants in the sample were close to three and one-half years of age. The specific purposes of this follow-up study may be summarized as follows:

1) To examine changes in the nature and frequency of occurrence of the serial ordering and object grouping behaviors observed in infancy and

at age three and one-half, when language has presumably begun to play a considerably more significant role in cognitive behavior. Partly because of this latter fact, it was decided to present the sorting tasks to the older subjects under two conditions: first, with the same general "spontaneous play" instructions employed when they were infants, and second, with quite specific instructions emphasizing sorting on the basis of similarities.

2) A second aim was to examine changes in some of the qualitative features characterizing the children's object arrangements. It has been observed by a number of investigators, including the speaker (9, 12), that sorting behavior of pre-school children is often characterized by groupings or arrangements which are highly configurational in nature, and appear to be determined more by successive juxtapositioning of similar as well as dissimilar objects on the basis of certain perceptual attributes or configurational possibilities than by an attempt to constitute groups on the basis of similarities and differences. As a matter of fact, in Inhelder and Piaget's recent work, the first stage in the genesis of classification behavior is postulated as the stage of "graphic" or "figural" collections, typically covering the age span from approximately 2 to 4-1/2. Since we had found virtually no configurational arrangements in the object grouping of our infants, we were interested in examining the extent to which such characteristics began to appear in their behavior at age three and one-half.

3) Finally, in view of the fact that there were rather appreciable individual differences found in both serial ordering and object grouping among the infants, we were interested in the question of whether these individual differences showed any stability over the developmental interval

between the first and second testing.

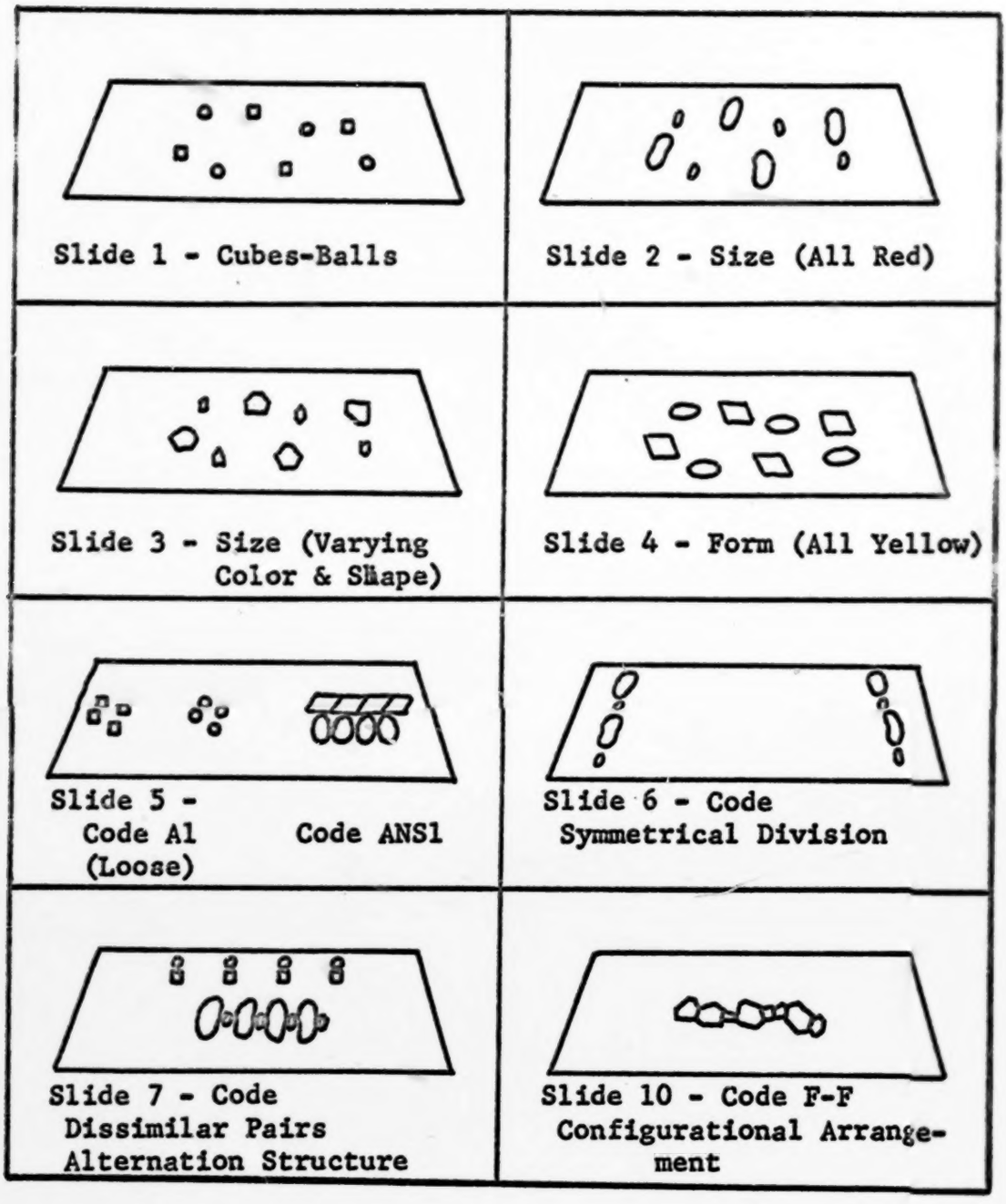
General Procedure:

Subjects:

Twelve boys and 10 girls from the 48 children originally examined as infants have been retested in the follow-up study thus far. At the time of original testing, these 22 infants were from 16 to 24 months of age, with a mean of 20 months. Upon re-examination they were between 39 and 44 months of age, with a mean of 40 months. The interval between original and follow-up testing ranged from 15 to 24 months, with an average interval of 20 months.

Tasks

In both the original and follow-up study, four different object grouping tasks were administered to each child. Each task consisted of four simple objects of one kind, four of another, presented on a masonite tray in a standard arrangement. One of the tasks (Slide 1) consisted of small yellow cubes and slightly malleable clay balls, thus providing between group contrasts in color, shape, and tactual properties. On two of the tasks, similarities and differences in size represented the salient grouping cues. In the first of these (Slide 2) the large and small objects, which were simple masonite cutouts, were of identical color and virtually identical shape. In the other (Slide 3) the large and small objects varied unsystematically in both color and shape. Finally, one of the tasks (Slide 4) presented a contrast in form only, consisting of 4 identical ellipses and four identical parallelograms. Half the children received the tasks in the order just described, half in the reverse order.


Slide 1 - Cubes-Balls
Slide 2 - Size (All Red)
Slide 3 - Size (Varying Color & Shape)
Slide 4 - Form (All Yellow)
Slide 5 - Code A1 (Loose)
Code ANS1
Slide 6 - Code Symmetrical Division
Slide 7 - Code Dissimilar Pairs Alternation Structure
Slide 10 - Code F-F Configurational Arrangement

Slides Illustrating Four Tasks and Sample Codings

Testing Procedure:

The testing procedure for each task involved placing the array of test objects in front of the child, who was then encouraged to play with them with such comments as "See these? --- you play with them - - - you fix them all up". The child was allowed a maximum of approximately 2 to 2 ½ minutes to play with the objects, during which time the examiner and one or two observers behind a one-way mirror made detailed records of the child's object manipulations. Since the procedure was intended to elicit "spontaneous" behavior, the examiner intruded as little as possible, except to encourage the child to continue playing with the objects if he became disinterested, or to rearrange them in the standard configuration if this were necessary. At the end of the indicated time period, if the objects had not been completely grouped, they were presented again on a tray with two recessed containers to provide additional physical cues which might facilitate sorting behavior.

In the original study, the testing procedure just described was employed with all four sorting tasks. In the follow-up study, the first two tasks given each child were presented with merely the general instructions to "play with them - fix them all up", thus paralleling the earlier mode of presentation. The last two tasks, however, were presented with specific sorting instructions essentially as follows: "See these -- they're all mixed up -- I want you to pick out the ones that are the same, or just alike, and put them here (pointing to one side of the tray), and then pick out all the other ones that are alike, or the same, and put them over on this side". Because of the counterbalancing of task order, half the subjects received general instructions for Tasks I and II, and specific instructions for Tasks III and IV, while for the remaining half of the

subjects, the reverse was true.[3]

Coding:

The behavior protocols were coded jointly by the examiner and one or two observers who pooled their observational records for this purpose. As already indicated, two major types of cognitively structured object manipulations were identified and coded for analysis in the first study. If you will refer to your handout (Appendix A), you will recall that the first type was concerned with the degree to which similar objects were manipulated in serial order (the C categories). Here, the coding system differentiates among successive manipulation of the objects in both groups (C1 for all 8 objects, C2 for 6 or 7), and successive handling of all four stimuli in one group only (C½). Manipulating all objects in a successive alternation sequence was also coded (C31).

The second major category is"similar object grouping." Here, the coding system differentiates between structures in which both object sub-sets are grouped and separated from each other (A1 and A2 codes), and those in which only one set of stimuli is grouped and separated from the remaining stimuli (B1 and B2). (In both instances a distinction is made between complete or "errorless" groups and incomplete or partially correct groups.)

The remaining structure codes on the back of your handout reflect ob-

3. Specific instructions always followed general instructions, rather than being counterbalanced, for two reasons: a) the small number of subjects available made it difficult to counterbalance both order of instructions and task order; and b) the general instructions "set" could not effectively be employed with subjects who have just been tested with specific instructions. Subsequent interpretations of "instructional" differences in sorting behavior must therefore be tempered by the fact that specific instructions always occurred after some experience with general instructions.

ject arrangements which were observed primarily at the 40 month level. Sometimes similar objects were grouped together, but the two groups remained in close spatial juxtaposition, rather than being separated. Slide 5 provides an illustration of such an arrangement, at the right side of the tray, coded ANS1. For comparative purposes, the arrangement at the left of Slide 5 portrays a loose A1 grouping. The BNS code in your handout refers to the setting up of a single group of objects which remain closely contiguous to some of the dissimilar objects.

The fourth set of coding categories includes arrangements in which dissimilar objects are grouped together or arranged configurationally. In Symmetrical Division, the objects are divided into two groups, each containing two of one kind, two of the other. Slide 6 shows an example of Symmetrical Division in which the objects happened to be arranged on the tray in a configurational manner. Arranging the 8 objects into four dissimilar pairs is shown at the top of Slide 7, which also illustrates a successive alternation structure in the lower half of the slide. It should be mentioned, finally, that responses were coded independently for both order and structure, or grouping characteristics.

Results:

The first analyses to be reported are concerned with group comparisons of performance at 20 and 40 months of age, in terms of the coding categories just outlined (Figure 1). For each coding category, we determined the percentage of children in each age group whose performance revealed the indicated behavior. In the present analysis, these category percentages actually represent averages across tasks.[4] You will note that the percentages for

4. These are independent percentages, which consequently do not sum to 100 across categories for a particular age group.

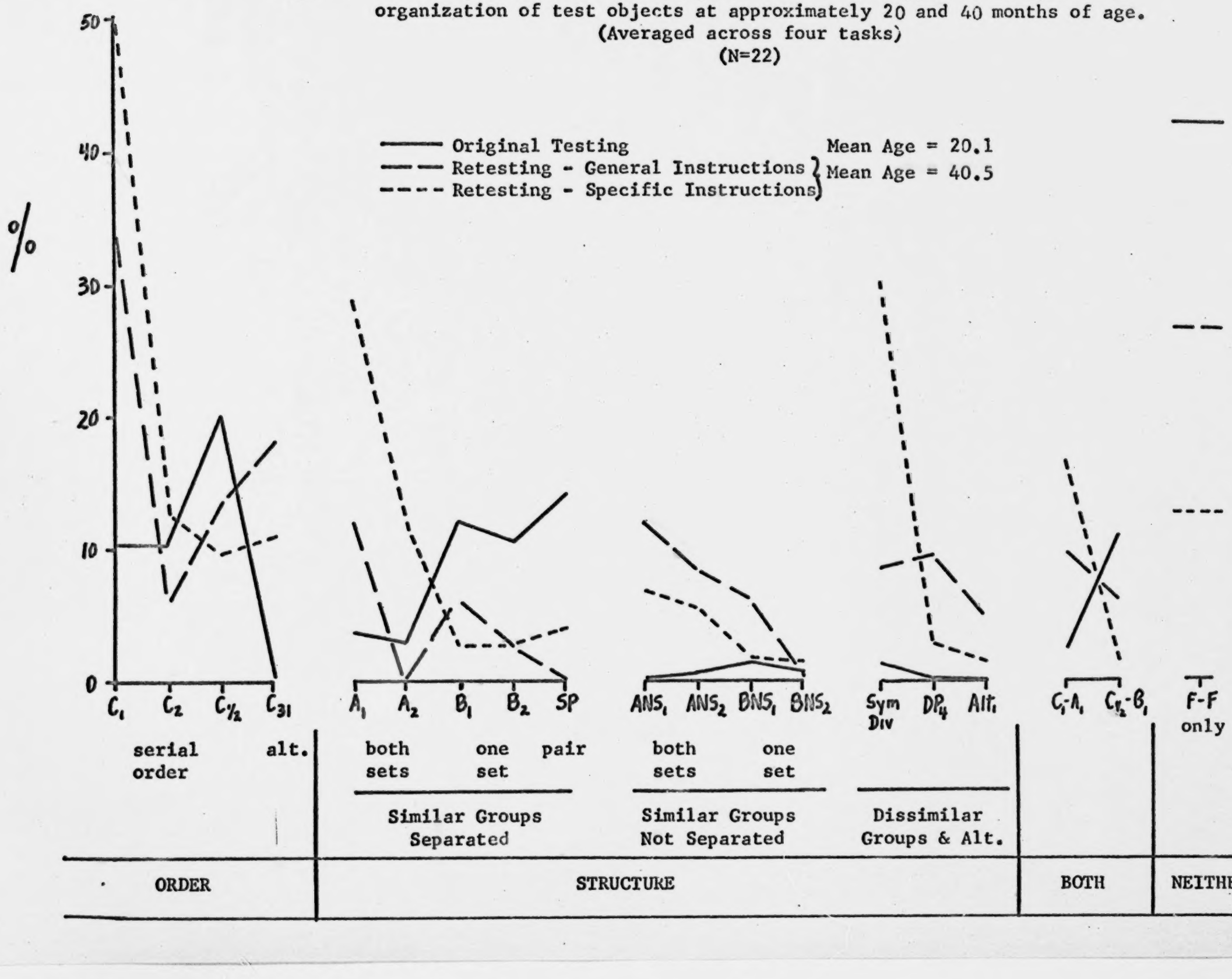
the 20 months testing are shown by a solid black line, while for the retesting data at 40 months the proportions are indicated separately for the general instruction condition (broad-dotted line) and the specific instruction condition (short-dotted line).

Let's consider first the results obtained with regard to serial ordering. At 20 months, the most common ordering behavior consisted of successive manipulation of four objects of one kind ($C\frac{1}{2}$), which was observed in 20 percent of the infants. Successive manipulation of the objects in both groups (C1, C2) appeared only half as frequently. Also, virtually none of the younger children showed any tendency to handle the objects in an alternation sequence (C31).

When the infants were retested at 40 months, successive manipulation of all 8 objects in both groups (C1) occurred more than three times as frequently as at 20 months, even with the general instructions to simply "play with", or "fix" the objects ($p<.003$). With more specific sorting instructions this percentage increased from 34% to 50%. Conversely, serial ordering of four objects of one kind ($C\frac{1}{2}$) occurred significantly less often at 40 months than at 20 months ($p<.02$). It will be noted that C1 ordering was clearly the most frequent of all types of manipulative organization observed in the older group. Finally, it is particularly interesting that about 15% of the older children manipulated the objects in a successive alternation sequence, while this behavior was virtually never seen at 20 months ($p<.02$).

Let us turn next to the question of the frequency with which similar objects are spatially constituted as separated groups. Considering the 20 month data first, it will be noted that the most common type of object grouping involved the placing together of all or most of the objects

Fig. 1. Percentage of children showing each of various types of manipulative organization of test objects at approximately 20 and 40 months of age. (Averaged across four tasks) (N=22)



in one group only (B1, B2), or the pairing of two similar objects (SP). Each of these behaviors was observed in slightly more than 10 percent of the 20 month infants. Grouping of both sets of objects (A1, A2) was observed in only a few instances in the younger infants.

At 40 months of age, there was a sharp rise in complete grouping of both sets of objects (A1), particularly with specific sorting instructions ($p<.01$), when approximately 30% of the children showed this behavior. (This percentage was also significantly greater than that obtained under general instructions ($p<.02$)). Correspondingly, there was an appreciable and significant decline at 40 months in the structuring of single groups (B1 or B2) as well as similar pairs, which were the most common group structures at 20 months (p's from .07 to .001).

As indicated earlier, serial order and types of group structures were coded independently in the child's behavior. It was felt to be of considerable interest therefore, to examine the relative frequency of two types of response combinations, in which selective ordering and object grouping occurred jointly in the same behavior sequence. The first of these, shown at the right side of Figure 1, involves the joint occurrence of C1 ordering and A1 grouping (C1-A1), while the second involves serial displacement and grouping of all four objects in one sub-set ($C\frac{1}{2}$ - B1). Both these response combinations tended to occur considerably less frequently than either serial ordering or similar object grouping alone. In the 20 month olds, $C\frac{1}{2}$-B1 responses were observed in 11% of the children, while C1-A1 occurred very infrequently. At 40 months of age, however, the opposite trend was found particularly with specific instructions. In this instance, C1-A1 response sequences were shown by 16% of the children, (significantly more than at 20 months ($p<.03$)), while $C\frac{1}{2}$-B1 combinations

almost never occurred (significantly less than at 20 months ($p<.01$)).

We turn next very briefly to the ANS and BNS categories, in which similar objects are grouped together but are not distinctly separated from one another. These structures were virtually never shown by the infants at 20 months, but were observed in a fair number of the children at 40 months.[5] For the most part, these non-separated configurational groups occurred somewhat more often under general than under specific instructions.

Finally, considering the three types of responses in which dissimilar rather than similar objects are grouped together or arranged configurationally, it is apparent that these occurred almost exclusively at 40 months. The most frequent of these, Symmetrical Division, was observed in 30% of the older children tested with specific sorting instructions, but in only 8% of the children given general instructions ($p<.035$). The remaining two structures, (DP4 and Alternation), were never seen at 20 months but were observed occasionally at 40 months (significantly more often in the case of DP4 under general instructions).

It would be well at this point to consider very briefly how often the children failed to show any of the response categories of order or structure we have just been discussing. At the extreme right of Figure 1, it will be noted that on the average task presentation, approximately 40% of the 20 month old children showed neither selective ordering nor object grouping behavior. However, at 40 months of age this percentage dropped significantly, to 25% when the children were tested with general instructions ($p<.005$), and to 12% when given specific sorting instructions ($p<.001$).

5. Only significant difference between 20 and 40 months was that for ANS1 under general instructions ($p<.02$).

The next analyses were concerned with a comparison of configurational and non-configurational characteristics in both the grouped and ungrouped object arrangements produced by the children at 20 and 40 months. For each codable object arrangement, it was noted whether the objects had been placed in the containers, grouped loosely on the tray surface or in the child's own hands, or arranged in a clearly configurational or patterned manner on the tray. Table 1 presents the proportions of object arrangements of various types showing each of these characteristics.

Consider first the disposition of the type A and B separated groups. At 40 months of age, slightly more than half of these object groups were arranged configurationally, i.e., they were either lined up in rows, stacked, placed in tight clusters, etc. By contrast, none of the A or B groups produced by the children at 20 months showed any of these configurational qualities. Nearly three quarters of such object groupings in the younger children took the form of loose clusters, about half of which were on the tray surface, half held in the child's hand. The remaining 27% were placed in containers.

Consider next the figures at the bottom of the table, concerned with arrangements which failed to show any of the object grouping characteristics in the coding system. Even in such instances, there is a clear tendency for configurational arrangements to be produced at 40 months, but not at 20 months, as indicated by the comparative percentages of 36 and 3 at the bottom of the right hand column (See Slide 10 for an illustration).

Little need be said about the ANS and BNS categories, since they are essentially configurational by definition. The Symmetrical Division and Dissimilar Pairs responses provide further examples of the configurational

Table 1

Proportion of object arrangements with configurational and non-configurational qualities

Type of Arrangement	Age Group	Non-configurational		Configurational	Number of responses
		Containers	Loose Groups (Hand or Tray)	Lined, stacked, tight clusters, etc.	
Separated Groups (A and B)	Older	16.7	31.5	51.9	(54)
	Younger	27.5	72.5	0	(51)
Non-Sep. Groups (ANS and BNS)	Older	0	9.4	90.6	(32)
	Younger	0	0	100.	(4)
Sym.Division Diss. Pairs	Older	74.4	2.6	23.1	(39)
	Older	0	18.8	81.3	(16)
Non-Grouped Arrangements	Older	28.3	35.4	36.4	(99)
	Younger	57.5	39.5	3.0	(167)

arrangements produced by some of the 40 month children. Sometimes the objects were not only divided symmetrically on the tray surface, but the internal arrangement of the two groups was quite isomorphic, as illustrated earlier in Slide 6. At other times the four edges of the tray seemed to serve as a figural "anchor", along which objects could be arrayed, perhaps in Dissimilar Pairs.

The final portion of the analysis was concerned with the question of the stability or consistency of individual differences in grouping behavior from 20 to 40 months. To examine this question, we assigned each child a numerical score for each of the testing occasions, reflecting the extent to which his behavior had been characterized by selective ordering and similar object grouping. When the mean scores at 20 and 40 months were compared, the 40 month scores were significantly higher ($p<.01$), as one might have expected from the previous analysis by categories. However, there was essentially no relationship between the children's scores at 20 months and at 40 months. If anything, the relationship was slightly, but insignificantly negative, with a Pearson r of -.18.

Conclusions and implications:

An appreciable amount of primitive categorizing behavior may be said to make its appearance as early as the second year of life, in the infant's spontaneous manipulation of simple test objects. Such behavior is primarily observable in two forms: serial or selective manipulation of one set of similar objects presented as part of a larger array, and spatial grouping of 2, 3, or 4 similar objects.

At 40 months of age, children show a marked overall increase in

serial ordering and object grouping behavior. One of the major features of this change at 40 months is that selective ordering and grouping tend to be imposed on all 8 objects in the array, rather than on one sub-set of 4 only, which was typical at 20 months. This tendency to impose structure on both sub-sets of test objects is apparent even under general instructions to "play with" or "fix" the objects, although it is considerably more marked when the children are instructed specifically to sort the objects into two groups.

The rather marked configurational characteristics seen in both the grouped and non-grouped arrangements of the children at 40 months are certainly in line with previous observations of pre-school children's sorting behavior, particularly with geometric stimuli, and they are also consistent with Inhelder and Piaget's description of the 1st stage of "graphic" or "figural" collections in the development of classification behavior (2-4½ years).

Perhaps one of the most interesting questions raised by this research has to do with the nature and developmental significance of the rudimentary, non-configurational categorizing behavior seen in the 20 month old infants. Our findings suggest that in the development of categorization behavior there is a pre-verbal period before the first "graphic" or "configurational" stage described by Inhelder and Piaget when primitive manipulative categorization on the basis of object similarities is observable. How the cognitive structures presumably associated with such behavior change with development is a most intriguing and difficult question.

With regard to the increasing tendency to arrange both similar and dissimilar objects configurationally, common at 40 months, one might suggest that such behavior reflects an increasing elaboration of cognitive

structures available for guiding the child's manipulative organization of the objects. Under some circumstances, or at certain points in development, configurational tendencies may be prepotent as determinants of the child's manipulative behavior, even though he may have the capacity to group objects on the basis of similarities alone. In such instances similar object grouping may be difficult to elicit, particularly if relatively free sorting is asked for. Perhaps this might help to explain why some of our infants who did a great deal of selective ordering and object grouping at 20 months produced very little such behavior at 40 months, but showed a good deal of configurational patterning of both similar and dissimilar objects. Hopefully, better answers to questions such as these may be forthcoming as more research is directed toward them by various investigators.

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Developmental Changes in Categorizing Behavior from infancy to early pre-school years

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Appendix A

Abbreviated coding definitions for major types of manipulative organization imposed on test objects

I. Selective ordering (structuring shown by order in which objects are manipulated or displaced; coded independently of whether objects are spatially constituted as groups)

C_1 -- 4 of one kind of object followed by 4 of other kind are manipulated serially.

C_2 -- 4 of one kind and 3 of other, or 3 of one type and 3 of other manipulated serially.

$C_{\frac{1}{2}}$ -- 4 of one kind manipulated serially.

C_{31} -- 8 objects are manipulated in a successive alternation sequence.

II. Similar object grouping (structuring shown by objects being spatially constituted as groups; coded independently of selective ordering).

Both groups:

A_1 - Four objects of each kind are displaced from original location and constituted as spatially separated groups.

A_2 - Incomplete or partially correct groups are constituted and spatially separated (at least 3 of a kind in each group).

One group:

B_1 - All 4 objects of one kind are constituted as a group and spatially separated from other objects.

B_2 - Incomplete or partially correct group constituted and separated from others (3 of one kind, or 4 of one kind plus one of other).

Pairs

SP - Two similar objects placed or held together and separated from remaining objects.

III. Similar object grouping without separation

Both groups:

ANS_1 - Same as A_1, but groups are not spatially separated from each other.

ANS_2 - Same as A_2, but groups are not spatially separated from each other.

One group:

BNS_1 - Same as B-1, but group not spatially separated from all other objects

BNS_2 - Same as B-2, but group not spatially separated from all other objects

IV. Dissimilar object grouping and alternation structures

Sym. Div. - Symmetrical Division - Eight objects are divided into two separated groups, each consisting of 2 objects of one kind, 2 of the other.

DP_4 - Eight objects are divided into four pairs of dissimilar objects.

Alt. - Eight objects are arranged in a successive alternation pattern (e.g. XOXOXOXO)